

Minutes & Slides from Proton Driver RF Meeting – October 12, 2004

(G.W. Foster)

SUBJECT: Circulator Tests, Phase Shifter Status, 325 MHz Collaboration Plans

Attendees: Ding Sun, Milorad Popovic, Iouri Terechkine, Dave Wildman, Victor Yarba, Timergali Khabibouline, Gennady Romanov, Giorgio Apolinari, Fernanda Garcia, Pierre Bauer, Bill Foster

AGENDA:

- 1) Tests of 325 MHz stripline circulator prototypes (Ding Sun)
- 2) 1300 MHz high-power waveguide phase shifter status (Iouri Terechkine)
- 3) High-powered Coax Tuner test plans (D. Wildman)
- 4) 325 MHz front-end linac collaboration plans with ANL, KEK,... (G. Romanov)

MINUTES

1) **Test results on a prototype 325 MHz circulator** were reported by Ding Sun of AD. The design targets use in a "strip line circuit board" which will contain all parts for a medium-power I/Q modulator module: i.e. circulator/isolator, branch-line-hybrid, and YIG ferrite tuning stubs. This module will provide independent RF phase and amplitude control for one SCRF cavity in a front end linac powered by a single Klystron. The prototypes use G-510 YIG ferrite rings from Dave Wildman's coax tuners 3" OD x 1/2" ID x 1/2" width. Bias fields of ~400 Gauss are provided by George Krafczyk's Main Injector corrector magnet.

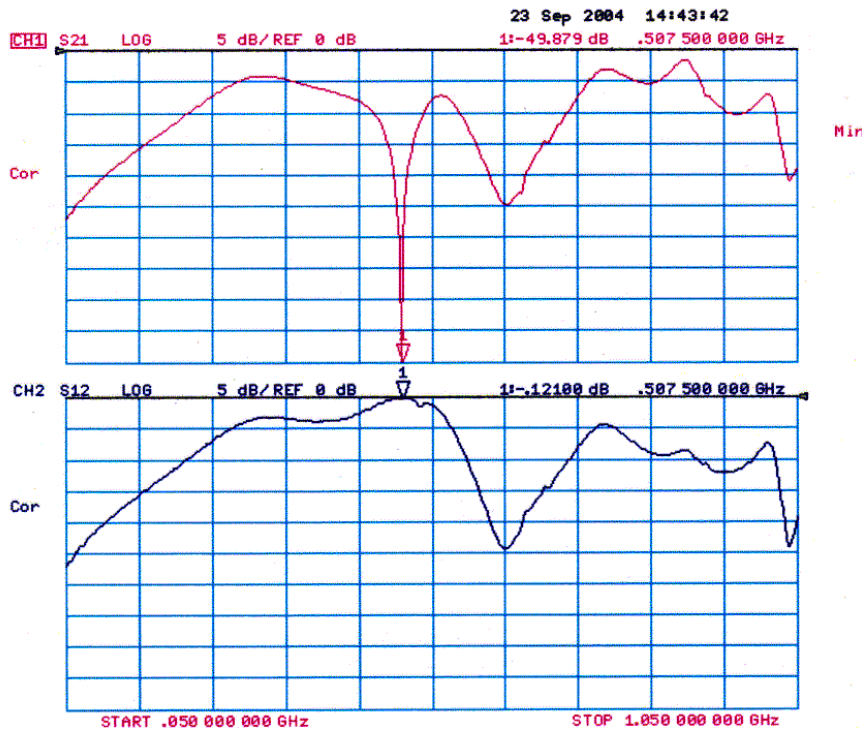
Ding has achieved good results both with a "standard" circulator design, and also a novel one which places a conductive post in the center of the circulator disk. The center post has advantages for heat removal from the ferrite, and also drops the operating frequency by 10-20% resulting in a more compact circulator.

Typical results (see figure) include:

- a) Isolation of -30dB to -50dB at center frequency (top plot)
- b) Insertion loss of ~0.1 dB (or ~2% power loss) (2nd plot)
- c) Matching loss of -25-35 dB (3rd plot)

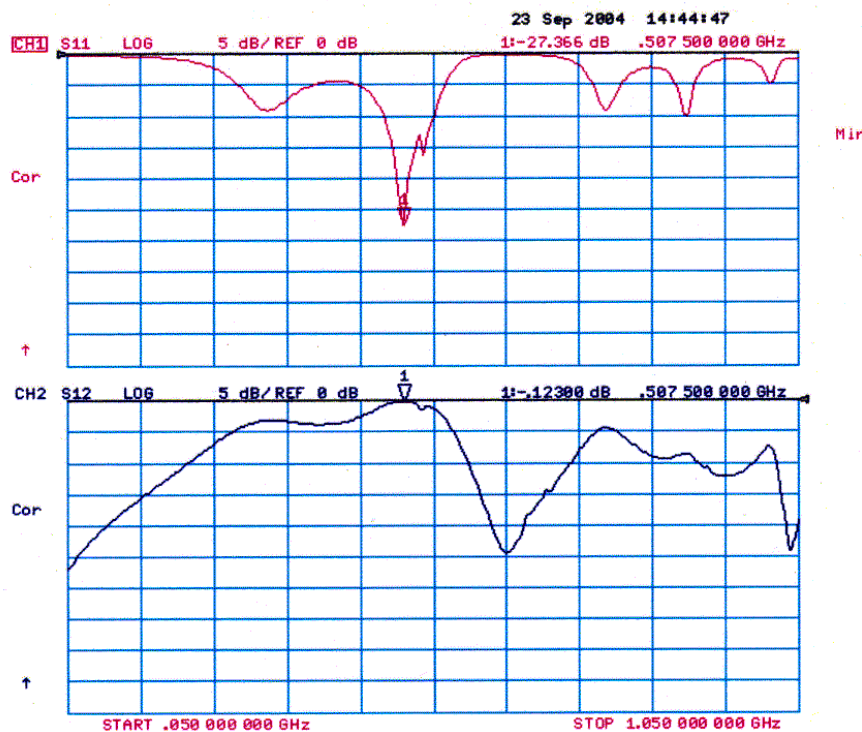
These numbers are about as good as you can get with a store-bought circulator, and better than we need for the SCRF cavity I/Q modulator application. The 3" diameter disks yields best operating frequencies in the range of 350-500 MHz (depending on bias field and stripline port geometry) so the disk OD will have to be increased to 3.5"-4" diameter for 325 MHz operation.

Ding does have a variant which works acceptably at the 352 MHz RF available from the Klystron test stand at the Argonne APS. So we should be able to do peak & average power testing at this frequency. This will require upgrading the connectors on the circulator to 7/8" coax or similar. These circulator tests could be folded into Dave Wildman's planned expedition to ANL for high power testing of the coax tuners at 352 MHz.



0.340V

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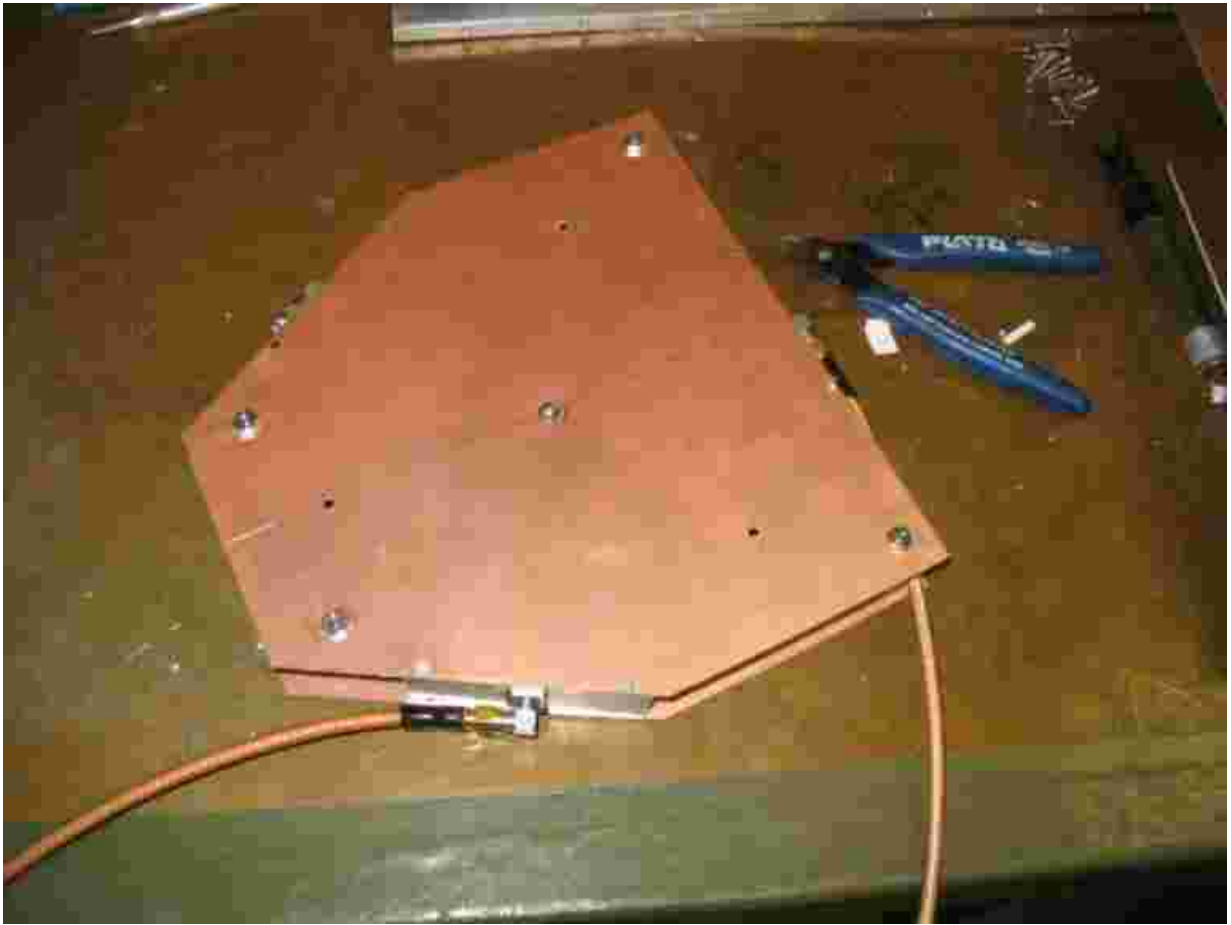


Ding Sun's measurements of his prototype circulator (representative results, in this case biased for 500 MHz operation and including the metal center post through the ferrite).

Top Plot: Isolation, in this case -49dB.

2nd from top: insertion loss = 0.12dB or about 3% power loss.

3rd and 4th plots: Matching reflection loss, in this case -27dB

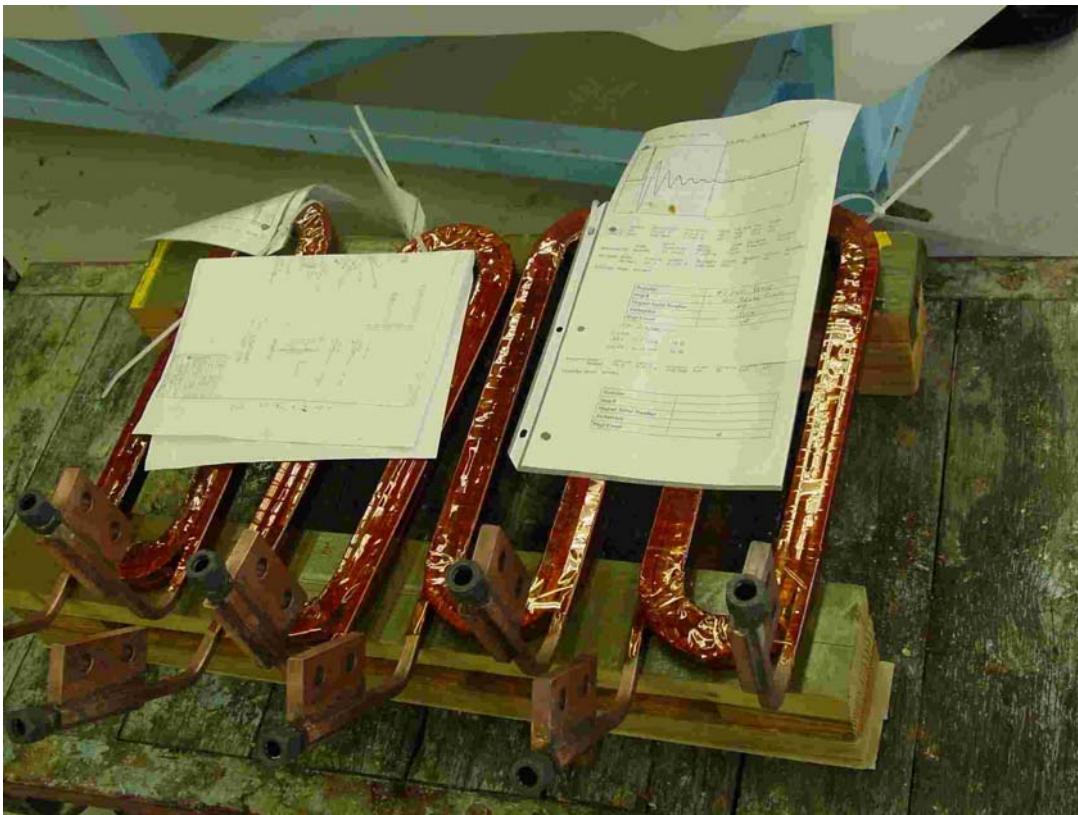


Ding Sun's circulator prototype.

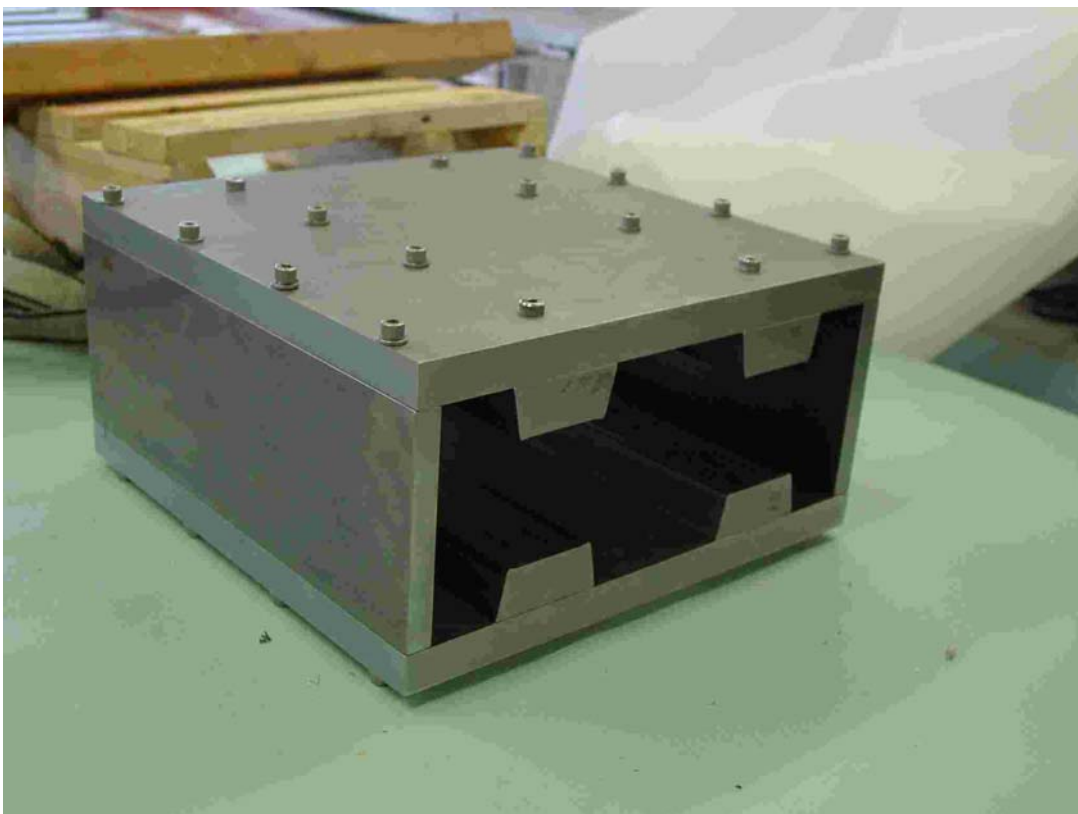
2) An **Update on the high-powered 1300 MHz waveguide style YIG tuner** stubs was given by Iouri Terechkine. The ferrite (finally) arrived, the coils are done & tested, the steel magnet yoke is complete, and the waveguide has undergoing its final brazing to fix up some bad corners. The power supply that Dave Wildman has been using at A0 should be adequate to drive the bias coils under slow (DC) conditions. A faster, higher-voltage supply and a ferrite return yoke will be needed for high-speed operation of the phase shifter. There still options under discussion on how to best trim the YIG bricks before gluing them into the waveguide.



Water-cooled waveguide for high-powered 1300 MHz YIG tuner



Bias coils for waveguide tuners.



Flux Return for waveguide tuner

3) Dave Wildman reported that **tests of the "fast" version of the Coax tuner** are still waiting for the 300V / 100A power supply from Steve Hays. He believes that he has all the rest of the parts for the test ready to go.



High-speed version of the Coax phase shifter

4) Gennady Romanov described plans and potential collaboration on the 325 MHz front end linac which feeds the SCRF spoke resonators. Collaboration plans are in flux, but some possible elements include

a) Doug Moehs is investigating the best H- source design to beg/borrow/steal/copy for the 325 MHz linac. Candidates designs include TRIUMF, SNS, DESY, & JPARC.

b) The RF Quadrupole from the KEK/JPARC joint project (30 mA, 3 MeV, 2.5% duty factor, 324 MHz tunable to 325MHz) looks ideal for this project. Initial contacts with KEK have yielded a positive response, and discussions should continue next week at the HB2004 conference in Germany.

c) There are a number of possibilities for the "first DTL Tank", including copying the KEK DTL, independent copper resonators, or going straight to SCRF.

Gennady's slides are at

http://tdserver1.fnal.gov/8gevlinacpapers/meeting_minutes/RF/Romanov_325MHz_Collab_Oct12_04.ppt